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ABSTRACT

A study was conducted to investigate the power of motor coordination for estimating intellectual performance and personality characteristics. Comparisons of the results were made by using two statistical techniques, univariate and multivariate, in terms of the appropriate technique for analyzing the data. Data consisting of six intellectual tests, thirteen personality characteristics, and eleven coordination items were collected from 130 students in sixth and seventh grade classes. Both the multiple regression and the canonical correlation techniques were used for analyzing the data. Results of the study indicated that motor coordination items were more powerful estimates for intellectual performance than for personality characteristics. The multivariate analysis was found to be more appropriate than the univariate technique. (Authors/JN)

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Estimating Intellectual and Personality by Motor Coordination Using Univariate and Multivariate Techniques

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Abstract

The purposes of the study were to investigate the power of motor coordination for estimating intellectual performance and personality characteristics; and to compare the results of using two statistical techniques, univariate and multivariate in terms of the appropriate technique for analyzing these data. Using 130 boys and girls in sixth and seventh grades, data consisting of six intellectual tests, 13 personality characteristics and 11 coordination items were collected. Both the multiple regression and the canonical correlation techniques were used for analyzing the data. The results showed that motor coordination items were more powerful estimators for intellectual performance than for personality characteristics. The multivariate analysis was found to be more appropriate than the univariate technique.

Univariate and Multivariate Relationships among Motor Coordination, Intellectual and Personality Characteristics

Relationships among intellectual performance, personality characteristics and physical performance have been studied from different points of view using different techniques of analysis. The preoccupation of educators and researchers in the area of development was to provide evidence supporting the existence of the relationships in terms of identifying both the degree and nature of those relationships.

In studying the relationship between two domains, namely, intellectual and physical performances, using a univariate statistical analysis, a number of studies have shown that there are significant relationships between the two domains (Ismail and Cowell, 1963; Ismail and Gruber, 1965; Olson, 1966; Singer, 1968; Gruber and Kirkendall, 1969). Using different multivariate statistical analyses similar results have been provided supporting those relationships with more information concerning the degree and nature of its structure (Ismail, 1968; Ohnmacht and Olson, 1968; Kirkendall and Ismail, 1970; Ismail, 1972; Chisson, Thomas and Biasiott, 1972; Thomas and Chisson, 1972).

A significant number of studies have been conducted to study the relationships among three domains collectively by relating personality characteristics to physical and intellectual performances. Using univariate statistical analysis, some researchers have found that there are significant relationships among the three domains taking two at a time (Klausmeier and Feldhusen, 1964; Ismail and Kirkendall, 1970). Such relationships are not adequate and the univariate statistical analyses may not be even appropriate in providing complete information as to the nature and degree of

these relationships (Gruber and Kirkendall, 1971, 1973). Therefore, studies along this line should make use of multivariate statistical techniques instead of the univariate approach. Such studies have shown that physical, emotional and intellectual domains are related in a complex manner, and certain physical performance items; e.g., motor coordination, could be powerful predictors for estimating intellectual performance (Ismail, 1964; Brown, 1964; Ismail and Gruber, 1967; Ismail, Kane and Kirkendall, 1969; Kane, 1970; Kirkendall and Gruber, 1970; Gruber and Kirkendall, 1971, 1973).

The purpose of the study is to compare the ability of selected coordination items in estimating intellectual performance and personality characteristics using univariate and multivariate statistical approaches. In particular, the study attempts to investigate the adequacy of the multiple regression technique (univariate approach) in comparison with the canonical correlation (multivariate approach) in estimating either intellectual performance or personality characteristics.

Method

Subjects

The subjects involved in the study were 130 elementary school children from Kokomo, Indiana. In selecting the subjects, four criteria were adequately met: a) age ranged from 10 to 13 years; b) both sixth and seventh grades were represented; c) both boys and girls were represented; and d) different motor coordination levels were included.

Assessment of Intellectual Performance

Intellectual performance was measured by selected six standardized tests; three of them were intelligence tests: a) Factor B of the Children's Personality Questionnaire Form A (Porter and Cattell, 1975); b) The Otis Lennon Mental Ability Test (Otis IQ), Elementary II, Form J (Otis and

Lennon, 1967; c) The Culture Fair Intelligence Test (CFIQ), Scale 2, Form A (Cattell and Cattell, 1973). The other three tests were academic achievement tests, from the Iowa Test of Basic Skills, Form 3 (Lindquist and Hieronymus, 1964): a) Reading Achievement, b) Arithmetic Concepts, and c) Arithmetic Problem Solving.

Assessment of Personality Characteristics

Personality characteristics were measured by the Children's Personality Questionnaire (CPQ) (Porter and Cattell, 1975). The questionnaire consists of 14 independent factors; 13 of which measure different characteristics, which are expressed in a bipolar form describing each characteristic on a scale of 1-10 points.

Assessment of Motor Coordination

Motor coordination was measured by eleven selected items which were used in earlier studies (Ismail and Gruber, 1965, 1967; Ismail, Kane and Kirkendall, 1969; Ismail and Kirkendall, 1970). The items consisted of three items for arms coordination: a) Arms Stretching in 4 Counts (Arms Strt. 4), b) Arms Stretching in 6 Counts (Arms Strt. 6), c) Arms Bending in 8 Counts (Arms Bend. 8); five items for leg coordination: a) Hop 1 Right and 1 Left (Hop 1R & 1L), b) Hop 2 Right and 2 Left (Hop 2R & 2L), c) Hop 2 Right and 1 Left (Hop 2R & 1L), d) Hop 2 Left and 1 Right (Hop 2L & 1R), e) Alternative Leg Swing (Leg Swing): and three items for combined arms and legs coordination: a) Arm Leg 1, b) Arm Leg 2, and c) Arm Leg 3.

Procedure

Intellectual and personality tests were administered in class-rooms in seven different sessions in a random fashion. Motor coordination tests were administered in gymnasia or big rooms in which the tests were divided

among seven stations; each of which was administered by an examiner who had been well trained in administering those tests. Subjects were moving from one station to another until they finished all the stations. The subjects were randomized among stations in order to offset any order effect. The data were analyzed as follows: 1) Using the multiple regression technique, the multiple correlation R for each dependent variable was obtained. In addition, the average R was calculated for each of the personality and intellectual domains in order to present an overall picture for the relationships between motor coordination and the two dependent variables. 2) Using the canonical correlation technique the multivariate correlation was obtained for the personality and intellectual domains with the motor coordination set taking one at a time. Effort was made to keep the degrees of freedom as constant as possible so that the results were not affected by the difference in the degrees of freedom.

Results

Univariate Relationships

In order to compare the relationships between motor coordination and intellectual performance in one hand, and between motor coordination and personality characteristics on the other hand, the best three estimators of motor coordination items obtained by multiple regression analysis for each relationship were considered. The reason is to maintain the degrees of freedom constant and the comparison will be based on the magnitude of the correlation coefficient R.

Insert Table 1 about here

Motor coordination and intellectual performance. Table 1 shows that the range of R was between .67 and .77 with the highest estimated item for intellectual performance by motor coordination items was Reading Achievement, and the lowest estimated item was Factor B. All of the R's were significant with $P < .01$ with an average of $R = .70$. The most frequent appearing motor coordination items in estimating the intellectual performance tests were: Arms Stretching 6, Arm Leg 1, Hop 2R & 1L, and Leg Swing, in this respective order.

Insert Table 2 about here

Motor coordination and personality characteristics. Only ten significant relationships were found; and thus, three personality characteristics were not related to motor coordination. Table 2 shows that the range of the significant R was between .24 and .50 with the highest personality characteristics estimated by motor coordination items were: Factor A which deals with reserved and detached, versus warmhearted and outgoing; followed by Factor C which deals with emotional instability, versus emotional stability; then by Factor O which deals with self-assured and placid, versus apprehensive and worrying. The lowest estimated characteristics were Factor G which deals with expedient, versus conscientious; Factor N which deals with forthright and natural, versus shrewd and calculating; and Factor Q_4 which deals with relaxed, versus tense. All of the R's were significant with a range between $P < .05$ to $P < .01$ with an average of $R = .32$. The most frequent appearing coordination items for estimating the personality characteristics were: Arms Stretching 4, Leg Swing, Arm Leg 1, Hop 1R & 1L, Arms Bending 8, and Arms Stretching 6, in this respective order.

Multivariate Relationships

The canonical correlation was used to determine the multivariate relationships among the three domains taken two at a time. Furthermore, the relative contribution of each item within a domain to the overall relationship was also identified between each two domains (Cooley & Lohnes, 1962; Van Der Geer, 1971; Morrison, 1976). The canonical correlation analysis was run between motor coordination items and intellectual performance tests in one anslysis; and between motor coordination items and personality characteristics in another analysis. The Wilk's Lambda and Chi-square were used for testing the significance of the canonical correlations, and only the significant canonical correlations were presented for interpretation. Only the largest root was found to be significant between either the motor coordination and intellectual sets or the motor coordination and personality sets.

Insert Table 3 about here

Motor coordination and intellectual performance. Table 3 shows that the canonical correlation between motor coordination items and intellectual performance tests was .83 which was significant with $P < .01$. In the intellectual variate, the variable which has the highest weight was Reading Achievement, and the variable which has the lowest weight was Factor B. In the motor coordination variate, the variables which have the highest weights were Arms Stretching 6, Arm Leg 1, and Leg Swing, in this respective order.

It is interesting to observe the agreement between the univariate and multivariate approaches in terms of the relationships between intellectual performance and motor coordination.

Insert Table 4 about here

Motor coordination and personality characteristics. Table 4 shows that the canonical correlation between motor coordination items and personality characteristic variate, the variable which has the highest weight was Factor A which deals with reserved and detached, versus warmhearted and outgoing; and the variable which has the lowest weight was Factor I which deals with tough-minded, versus tender-minded. In the motor coordination variate, the variables which have the highest weights were Arms Stretching 6, Hop 2R & 2L, and Leg Swing in this respective order.

Although these results are similar to those obtained from the univariate analysis, yet the order of the motor coordination items in terms of importance had been altered in a pervasive manner.

Discussion

The results showed that motor coordination items were powerful estimators for both intellectual performance and personality characteristics. The relationships among the three domains were highly significant. These results are in agreement with findings reported in previous studies (Ismail and Gruber, 1965, 1967; Ismail, 1967; Ismail and Kirkendall, 1970; Ismail, 1972; Thomas and Chisson, 1972). The power of motor coordination items for estimating intellectual performance tests was better than that of personality characteristics. This finding tends to indicate that the relationship between physical and intellectual domains was stronger and more stable than the relationship between physical and personality domains. This finding was vividly illustrated in both univariate and multivariate analyses.

In comparing the two statistical techniques univariate and multivariate analyses, the results showed that the items which had the highest weights on the intellectual and personality variates in the canonical correlation analyses happened to have the highest correlation coefficients in the multiple regression analyses. Also, the items which had the highest weights on the motor coordination variates in the canonical correlation analyses happened to be the most powerful estimators of the intellectual and personality items in the multiple regression analyses. Consequently, it is not surprising that the outcomes obtained from the application of the multiple regression analysis are similar to those obtained from the canonical correlation. However, the canonical correlation analysis tends to augment the results, and offers additional information to that obtained by the multiple regression analysis. Such findings suggest the superiority of the multivariate statistical procedure over the univariate approach in highlighting the relationships between the physical and either the intellectual, or personality domains.

It was interesting to observe that there were some intellectual performance tests such as Reading Achievement, Otis IQ, and Arithmetic Concepts that were estimated by motor coordination items better than others such as Factor B and Problem Solving. This observation may imply that there were differences between the intellectual tasks in relation to motor coordination items. Such differences may be related to the differences in processing different cognitive items. This phenomenon needs to be studied for more clarification and supporting evidences.

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Table 1

REGRESSION EQUATIONS OF INTELLECTUAL PERFORMANCE WITH MOTOR COORDINATION[a]

Intellectual Performance	R	Motor Coordination	Beta Weights
Factor B	.61**	Arm Leg 1	.13
		Arms Bending 8	.18
		Hop 2R & 1L	.10
		Constant	2.15
Otis IQ	.75**	Arms Stretching 6	2.01
		Leg Swing	1.09
		Hop 2L & 1R	1.46
		Constant	68.12
Culture Fair IQ	.67**	Arms Stretching 6	1.46
		Hop 2R & 1L	1.32
		Arm Leg 1	.74
		Constant	74.02
Reading Achievement	.77**	Arm Leg 1	.93
		Arms Stretching 6	.14
		Leg Swing	.10
		Constant	3.56
Arithmetic Concepts	.75**	Arm Leg 1	.12
		Arms Stretching	.21
		Hop 1R & 1L	.15
		Constant	.99
Problem Solving	.65**	Arm Leg 1	.08
		Leg Swing	.08
		Arms Stretching 6	.09
		Constant	3.98
Average	.70**		

[a]More information can be obtained upon request
** $P < .01$ with 126 degrees of freedom

Table 2

REGRESSION EQUATIONS OF PERSONALITY CHARACTERISTICS WITH MOTOR COORDINATION

Personality Traits	R	Motor Coordination	Beta Weights
Factor A	.50**	Arms Stretching 4	.32
(Reserved, Detached -vs-		Arm Leg 1	.12
Warmhearted, outgoing)		Hop 1R & 1L	-.14
		Constant	2.36
Factor C	.40**	Arms Stretching 6	.15
(Emotionally Unstable -vs-		Arm Leg 3	.12
Emotionally Stable)		Arms Stretching 4	-.17
		Constant	5.94
Factor E	.26*	Arm Leg 3	.14
(Obedient, Mild -vs-		Leg Swing	-.14
Assertive, Independent)		Hop 2R & 1L	.11
		Constant	4.33
Factor F	.28**	Arms Stretching 6	.26
(Sober, Prudent -vs-		Arm Leg 1	-.09
Happy-go-Lucky)		Leg Swing	-.08
		Constant	3.86
Factor G	.24*	Leg Swing	.08
(Expedient -vs-		Arms Stretching 4	-.14
Conscientious)		Hop 2R & 2L	.11
		Constant	4.88
Factor H	.35**	Arm Leg 1	.14
(Shy, Restrained -vs-		Hop 2R & 1L	.14
Venturesome)		Leg Swing	-.08
		Constant	3.42

Table 2 (Cont'd)

Personality Traits	R	Motor Coordination	Beta Weights
Factor J	.28**	Hop 1R & 1L	-.17
(Vigorous -vs-		Arms Stretching	.16
Circumspect)		Arms Bending 8	-.08
		Constant	6.11
Factor N	.24*	Arm Leg 1	-.12
Forthright, Natural -vs-		Hop 1R & 1L	.17
Shrewd, Calculating)		Hop 2R & 1L	-.11
		Constant	5.76
Factor O	.44**	Arms Stretching 6	-.15
(Self-Assured -vs-		Arms Bending 8	-.10
Worrying)		Leg Swing	.07
		Constant	6.78
Factor Q_4	.24*	Arm Leg 1	.07
(Relaxed -vs- Tense)		Arms Bending 8	.07
		Arms Stretching 4	-.08
		Constant	5.63
Average	.32**		

* $P < .05$ with 126 degrees of freedom

** $P < .01$ with 126 degrees of freedom

Table 3

CANONICAL CORRELATION BETWEEN INTELLECTUAL PERFORMANCE AND MOTOR COORDINATION

Intellectual Performance	Weights	Motor Coordination	Weights
Factor B	.00	Arms Stretching 4	-.12
Otis IQ	-.27	Arms Stretching 6	-.27
Culture Fair IQ	-.13	Arms Bending 8	-.08
Reading Achievement	-.46	Hop 1R & 1L	-.11
Arithmetic Concepts	-.21	Hop 2R & 2L	-.09
Problem Solving	.03	Hop 2R & 1L	-.02
		Hop 2L & 1R	-.06
		Leg Swing	-.15
		Arm Leg 1	-.26
		Arm Leg 2	.00
		Arm Leg 3	-.01
Canonical Correlation	.83**		

**p < .01 with 66 degrees of freedom

Table 4

CANONICAL CORRELATION BETWEEN PERSONALITY CHARACTERISTICS AND MOTOR COORDINATION

Personality Traits	Weights	Motor Coordination	Weights
Factor A	-.53	Arms Stretching 4	-.33
Factor C	-.42	Arms Stretching 6	-.60
Factor D	-.28	Arms Bending 8	-.18
Factor E	.10	Hop 1R & 1L	.37
Factor F	-.03	Hop 2R & 2L	.58
Factor G	.28	Hop 2R & 1L	-.27
Factor H	-.23	Hop 2L & 1R	-.17
Factor I	-.05	Leg Swing	.44
Factor J	.22	Arm Leg 1	.10
Factor N	.16	Arm Leg 2	-.42
Factor O	.42	Arm Leg 3	-.43
Factor Q_3	.28		
Factor Q_4	.23		

Canonical Correlation .64**

**$\underline{P}$ < .01 with 143 degrees of freedom